Peer Review Panel's review of drafts of issue papers

The following document contains Peer Review Panel comments on issue papers, synthesis paper and technical information submitted by the public.
Peer review panel meetings were held in Portland, OR in June 2000 and February 2001. The following comments represent a general consensus of the Peer Review Panel members. Comments pertaining to all issue papers are presented first, then comments on specific issue papers and the technical synthesis paper follow. Individual reviewer comments were noted directly on the draft manuscripts and returned to the authors. Author responses to Peer Review Panel comments are included after each review summary. Peer review comments for the Technical Working group regarding documents submitted by the public are at the end of this document.

July 2000

The peer review panel reviewed these documents using several assumptions:

1) that the audience for the issue papers includes several groups. These papers seem to be serving to summarize information for the technical working group, which is a group with substantial previous knowledge, as well introducing and providing a technical foundation for the policy group to understand stream temperature dynamics and biotic responses. We did not review these issue statements as if they were intended for the lay audience.

2) that maximum summer temperatures were the primary focus. We did not see any discussion of summer minimum temperatures or winter maximum or minimum temperatures and did not address the lack of this information. Reviewers recognize that changes to stream temperatures in seasons other than summer could have important biotic consequences, such as is observed in regulated streams, where the annual thermograph can be substantially shifted without exceeding high summer temperatures. However, high summer temperatures were assumed to be of primary importance and with the recognition that many of the same factors influencing high summer temperatures have been shown to lead to changes in temperatures in other seasons.

3) that stream temperatures only in rivers and streams (lotic systems) were being addressed. We note that temperatures in lakes and reservoirs also impact Northwest aquatic biota including migratory salmonids, but those temperature issues are not being addressed in these issue summaries.

A brief summary of the peer review panel discussion follows. These comments apply generally to all papers. Specific comments on each issue paper are presented after this section.

The panel recognizes and applauds the hard work that has been put into each paper. Summarizing aspects of a diverse and sometimes conflicting literature on something as complex as stream temperature is very difficult. Given the variety of biotic responses to stream temperature and the interactions between physiology, behavior, genetic history and environment, creating issue papers to be used for developing a regional temperature criteria is a great challenge. Our comments are intended to be constructive and helpful, with the idea of making the issue papers a stronger synthesis of the existing knowledge base.

We suggest that a consistent framework for all issue papers be adopted. The common structure of the papers should be decided up by the working group (for example, abstract/summary or objectives?, introduction, discussion, conclusions) and implemented to the extent possible in each issue summary. Conclusions, which should be supported by the examples, figures, tables and discussion in the text, are an important synthesis portion of each paper. Because we perceive these papers to be issue summaries, we felt that recommendations were not appropriate and should be removed from those papers. In several instances, we observed that recommendations were not supported by the content of the papers.

In addition to incorporating general organizational headings within all papers, we suggest that posing questions and then answering them could be an effective discussion tool within all the papers. Questions can help in focusing discussion of a topic, not only for the authors, but also for readers who are not familiar with the subject or with the potential issues and controversies involved. The questions and answers should address straightforward topics as well as those which are complex. Our suggestions for evaluating papers with differing views are presented in a later paragraph.

We recognize that it is difficult to divide topics among the issue papers. We found much overlap among papers, but also noted gaps in information, as is expected by having separate groups write portions of a comprehensive topic. However, it was apparent that working group members had not read all the issue summaries. Perhaps, the technical working group could take time during this meeting to outline each paper, list the major questions that each issue summary will address, and then examine overlap of topics.

We noted that information presented in tables was an efficient method to summarize pertinent studies. The panel suggests that more tables be used to present and summarize information in the physiology, behavior, and interaction papers and that column headings be expanded to clarify important differences among the studies being compared. For example, we suggest indicating and including whether the study was conducted in tanks or in streams, the acclimation temperature for each study, the stock used and whether the fish were native or

hatchery raised, the sample size, and the life stage of the fish would be valuable when comparing and discussing responses from various studies. These tables will be useful summaries for both the technical and policy working groups for evaluating and developing temperature criteria.

The panel also suggested that the spatial and temporal pattern and salmonid distribution papers incorporate many maps and figures for a clearer presentation of distribution and variation. Because the present landscape and distributions already impacted, current maps would ideally be able to be compared with historic maps. Although we don't know historic temperature patterns, it would be appropriate to discuss landscape changes and the impacts of those types of activities on stream temperatures. Historic distributions of salmonids are generally known and a brief discussion of zonation or why species occurred in specific areas would highlight differences among species and stocks. The distribution paper would be an appropriate place to discuss the differences between presence/absence and healthy populations with regard to stream temperature.

The metric or type of temperature being discussed should be clarified within each of the other issue summaries. When citing studies, identify, if possible, which temperature is being reported so that readers can compare across studies and among issue papers. This will also be useful for the next stage in this process of evaluating standards. Metric units should be used consistently throughout all papers; if temperatures need to be listed in Fahrenheit, they could be in parentheses after the temperature in Celsius.

In science there is always scientific uncertainty; some uncertainty arises from things we don't yet know enough about and some, such as historic stream temperature distributions, are things we will never know. The issue summaries will serve an important function if they are able to identify conflicts within literature on a topic and attempt to sort out the differences. Are the differences because a new idea has been suggested? Is it based on one observation or multiple? Is it well replicated or an outlier? Is it applicable to a specific site or subspecies or more generally to a region? Discussion of why studies may have obtained differing results will help those less familiar with the topic understand what scientists know and what they disagree upon versus what has been suggested but is unsubstantiated. These discussions may serve to further our understanding of stream temperature dynamics.

The peer review panel recommends that most credibility be accorded to studies that have been peer reviewed and appear in the primary literature. These studies are not without flaws, but they have been evaluated and reviewed by unbiased scientists who have also conducted research on that specific topic. Because of the level of review, these studies have the highest credibility. Unpublished theses have also been reviewed by several senior scientists, but have not been

evaluated to the extent that a manuscript in peer reviewed literature has. Agency reports, or grey literature, have had less review and often are presenting information that can not be obtained through peer reviewed journals. Reports by consulting firms have had even less review. The data in reports should be considered but the conclusions drawn may represent only those of the author because they have not been subjected to the scientific peer review process. In conjunction with this ranking of credibility, this panel recommends that caution be used when citations or implications drawn from a study were not obtained from the primary document for each study. Someone citing an article may draw different conclusions or have different assumptions than the original scientist who conducted the study. This is not to say that summary review articles are not useful or should not be cited, but that the original peer reviewed primary literature should be consulted.

In summary, we urge you to incorporate these general suggestions when revising the issue summaries. Your work on these issue summaries is providing an important synthesis of existing information and will be valuable as a foundation for the development of the regional temperature criteria.

Summary of Peer Reviewer's discussion of Draft of Issue Paper 1:
Salmonid Behavior and Water Temperature

July 2000

The authors have obviously worked to compile this information and present behavioral responses to temperature. However, this can be a confusing topic. During our discussion of this paper, reviewers unanimously agreed that presenting the majority of this information in tables will improve understanding by readers.

The tables will provide a useful summary for the technical workgroup, policy group and public. Column headings should be as comprehensive as possible to facilitate comparison among studies (also see summary comments of peer review panel). Several reviewers mentioned that there can be very different behavioral responses depending upon stocks used, acclimation temperature, feeding ration (fullness), wild vs hatchery, tank vs stream study, and life stage. What about the effects of fluctuating temperatures vs stable temperatures often used in studies? Reviewers suggest that the state of knowledge of behavioral responses to all these aspects should be clarified

to the extent possible. The citation of each study that is listed in a table should also be included, possibly as a footnote. The type of temperature being reported (max, mean, MWAT) should also be recorded and degrees Celsius should be used consistently throughout.

The conclusion and summary sections are good, and can become clearer by discussing the information presented and summarized in the tables. Reviewers encourage the authors to reference original citations and cite summaries less frequently. The reviewers were very concerned about the inclusion of speculative comments throughout the manuscript, and especially felt that the recommendations were not appropriate and not supported by the text.

In order to not distract readers and to help the flow of the manuscript, the terminology could be put into a glossary at the end.

Additional behavioral topics that reviewers felt should be addressed include:

temperature and life history patterns
effects of temperature on activity, feeding and concealment behaviors
behavioral responses and vulnerability to predation as a function of temperature
behavioral costs of acclimation
behavioral use of refugia and limitations to use
intra and interspecific behavioral dynamics

A discussion such as this would address the issues raised during public comments and provide a framework for thinking about genetic differences, effects of acclimation temperatures, effects of differing food rations, and effects of duration of exposure.

A reviewer suggested that an organizing idea could be to consider risks versus benefits of a behavior. The book "Behavior of teleost fish" would be a good reference for this approach. He recommended that the manuscript might have a clearer connection to the literature if behavior was addressed from this perspective.

Comments and suggested questions to address from reviewer # 5 were included for authors of physiology, behavior and interaction issue papers because the questions apply to all these papers and the topics overlap. Reviewers urged that there be increased communication among the authors of these papers to clarify which paper is dealing with which topic. Communication is also essential to avoid or at least explain why there may be conflicting temperature responses.

Reviewer #4 commented that in central California, they have found temperature responses to occur at different levels than those cited within the manuscript. Although California salmonids may have different temperature dynamics (due to higher acclimation temperatures, different stocks, etc), similar comments may be raised regarding streams in eastern Oregon and Washington. These types of comments need to be addressed and put into perspective within the text of the manuscript.

Response from Technical Working Group Authors

October 13, 2000
Dear Dr. Johnson,

This cover letter outlines changes made to the EPA Behavioral Summary paper in response to the peer review comments. I have organized this letter responding to the peer review starting with the most substantive changes to the paper.

1. The paper has been organized into Abstract, Introduction, Discussion, and Conclusion sections.

2. Three tables have been added to the paper, as a result, large portions of text have been replaced by tables. The three new tables condense information on thermal preferences and life history stages of salmonids, making the information more accessible to the reader.

3. A question and answer format has been used to address behavioral topics, including temperature and life history patterns, the effects of temperature on feeding and activity, predation, competition, and cold-water refugia.

4. Table 2 is a summary of scientific studies listing the preference and avoidance temperatures of salmonids. All of this data is referenced from original citations. Throughout the paper an effort has been made to reference original citations, and cite summaries less often.

5. The column headings in Table 2 follow the suggested format of the peer review panel closely. In the 2nd paragraph of the Discussion section, leading up to Table 2, the general state of knowledge of behavioral responses to acclimation, feeding, fluctuating temperature regimes is
discussed.

6. The third paragraph of the Discussion section deals briefly with temperature metrics. Temperature metrics are provided in Table 2 whenever this information has been provided by the authors, or could be determined from the methods section of the literature. In Table 4, which list the selected spawning temperatures of salmonids, for the purpose of setting water temperature criteria, we assume the ranges given represent daily average temperatures (DAT); this is given in the table description and in the column heading.

7. Text dealing primarily with physiology rather than behavior was removed from the behavioral summary. Brief statements linking behavioral topics to the other summaries were added to discussions.

8. The terminology section was reduced to a glossary and moved to the end of the manuscript.

9. Recommendations and all speculative comments were removed from the manuscript.

Sincerely,
Sally Sauter
Fisheries Biologist
Columbia River Research Laboratory

Summary of Peer Reviewer's discussion of Issue Paper 2:
Salmonid Distributions and Temperature

July 2000

Reviewers agreed that this paper's topic is an important one, but that the paper is incomplete in its present form. Suggestions were made that maps of species distributions or fish assemblages and zonation, both historic and present, would contribute greatly - especially if present distributional maps could include temperature (such as 303d listed streams?). ICBMP data might provide a starting place for distributional maps or 'streamnet' or NMFS.

The text could include some discussion as to why species historic ranges differed - what hydrologic, geologic or life history traits led to species presence only in certain areas. Present maps would need a brief explanation as to why ranges differ from historic distributions. Habitat loss (not just temperature) has led to changes and habitat degradation is also a factor (McIntosh is

a citation for this in eastern Oregon). McCullough (1999) noted collapse of ranges toward the headwaters because of changes in stream temperatures. The extent to which you might include or discuss the expansion of exotic species' distributions as a function of temperature was discussed by reviewers, but we were uncertain as to whether this summary was to focus only on salmonids or more general influences of increased stream temperatures on fish.

Although it is not the focus of this issue statement, it is important to distinguish between species presence/absence versus abundances or reproducing populations. (This gets into some discussion of quality of habitat, which is very difficult to distinguish from maps.) With your discussion of edges of species distributions and individual vs population responses to temperature you begin to address these issues and these ideas need to be expanded and clarified. Reviewers commented that the edge of distributions are the most dynamic for noting changes and can be population sinks during good times, but sources of recolonizers after disturbances. Much has been published on metapopulations and this manuscript is not the place to do a comprehensive review - but the discussion does need to be expanded, with the focus on fish and temperature.

Figure 1 needs reworked. None of the reviewers understood its message. Use of the term 'ecological relevance' may be confusing in this context, without lots and lots of discussion and clarification. Perhaps sticking to a discussion of individual presence vs population abundances would be more clear.

The paragraphs on dams and fish passage do not seem to fit and reviewers felt that those paragraphs are off the topic of this paper. Dams might be briefly mentioned as one of many factors leading to habitat loss or degradation.

All reviewers noted that the objectives were a good start as to what we expected from this manuscript and encourage the authors to refer frequently to those objectives as they revise this manuscript.

Response from Technical Working Group Authors

17 October 2000
Dr. Sherri Johnson
Oregon State University
Corvallis, OR 97331

Dear Dr. Johnson:

Thank you for thoughtful comments provided by yourself and the peer-review group on the salmonid distribution issue summary paper. The initial review provided several useful suggestions that we attempted to incorporate into the paper, while keeping the paper itself as concise as possible. The first review draft was apparently missing several pages of material, so unfortunately, many of the reviewers did not have a chance to read the entire document. Many of the initial omissions mentioned by the reviewers were actually contained in the missing portions of the paper. We thank you for taking extra time to review the full paper, after this miscommunication was addressed.

One major suggestion was to finely focus the paper on temperature. There were longer discussions of other factors that may affect salmonid distributions (e.g., dams, harvest, habitat loss) in the original draft. These have been minimized wherever possible. We left some material on non-thermal factors in the final draft to remind readers of the multiple problems that have precipitated the current salmon crisis. Many of these factors may interact with temperature, as emphasized briefly in the distribution paper, and more completely in the multiple stressors issue summary paper.

Reviewers noted that Figure 1 in the original draft was confusing. The figure attempted to diagram the different scales on which temperature can be considered, and the types of information that may be used at different scales. These concepts have been incorporated into the text of the paper to provide more clarity. Figure 1 was deleted.

We also presented a large table of references describing various kinds of studies relating salmonid distributions to different indicators of thermal habitat. Again, we decided to delete the table and provide a more concise discussion of the issues in the text. We did refer readers to an unpublished review by McCullough (1999) for more detail on salmonid distributions and temperature. Though not published in a journal, this review has received broad distribution, and extensive peer review (D. McCullough, personal communication).

We also deleted our section on recommendations/issues. This created some redundancy in the material. We condensed all of the major “sub” issues related to salmonid distributions into five major topics noted in the introduction. Wherever possible, we emphasized common issues or questions that frequently come up in dealing with temperature criteria. For example, the relevance of potentially suitable, but unoccupied habitat, and the “I saw a fish in hot water” phenomenon. We also attempted to use some everyday examples to highlight points for

readers with a less technical background.

A figure was added to illustrate the range of temperatures used by various fish species.

Finally, we added more detail on an issue that we view to be central to considering salmonid distributions in temperature criteria: the issue of attaining biological versus physical system potential. We phrased the issue in terms of four basic, simple scenarios. Some discussion of these different scenarios is provided, but we mentioned them more to emphasize that they must be explicitly considered in any analysis of water quality.

Thanks again for your help in clarifying the papers and the issues.

Regards,
Jason Dunham
US Forest Service

Summary of Peer Reviewer's discussion of draft of Issue Paper 3:
Spatial and Temporal Patterns of Stream Temperature

July 2000
Reviewers agreed that this paper addresses an important component and will be a valuable contribution towards increased understanding of temperature dynamics, especially for those working to establish temperature criteria. However, this paper contains many speculatory statements, which detract from the issues that are being addressed. Citations supporting statements of spatial and temporal variability and anthropogenic impacts need to be added (see additional comments by reviewer #2).

All felt that maps showing spatial variation of temperatures across the region would make this a stronger manuscript. Both present and historic maps would be valuable, although we recognize that historic distributions are generally unknown. Therefore, use of 'natural range of variation' as a standard is theoretically a nice idea but cannot be applied to most of our landscapes. It is a valuable for thinking about temperature variability and the biological and landscape implications but applying the concept is difficult.

Discussion of the lack of historic temperatures would help policymakers and general public understand what the limitations are. In order to lay groundwork about setting standards where we have no historic data and where streams are presently very warm in the summer, a general discussion of anthropogenic impacts to stream temperatures could follow the historic section (and be supported by figures or a table). These sections could then lead to a discussion that since most of our landscapes have been modified, and summer stream temperatures generally increase following anthropogenic impacts, historic summer temperatures were probably less than those observed presently. A discussion such as this would address the issues raised during public comments by OFCI and WFPA (attached) that natural baselines are 'crucial' to assessing how much stream temperatures have been affected by disturbances.

Because variation across space and through time is very complex, temporal variation could be more clearly addressed using several figures depicting examples of variation through a year, seasonally, diurnally. 'Cool at top/warm at bottom' (page 11) is confusing. It was not clear whether you were talking about stratification or longitudinal patterns. Perhaps change to cool in headwaters, warm downstream.

Terms such as thermal diversity and integrity were considered jargon and distracting from the presentation of spatial and temporal variation (see comments by reviewer #8, page 19). Because this topic of variation can be so broad, and our understanding that these issue summaries are to address state of the knowledge for setting criteria, comments were made that a focus on 'biologically important' temperatures may be appropriate. Which parameters are these? Summer maximum is obvious, but reviewers noted that factors such as minimum temperatures are correlated with spread of exotics species. Spatial variation is known to provide refugia, but at what scale? What is the minimum size of cool water patch that is useful?

Cumulative effects discussion is long and differences between first and second mechanisms were not clear. Reviewers felt that the footnote and comments in appendix A discussing Zwieniecki and Newton paper should not be included in this issue summary.

Figure 4 doesn't include any mention of increased direct solar inputs after removal of shade. Figure 6 is not a strong example of dam effects on temperature, could be deleted.

Figure 7 looks to be similar to Theurer et al. - should that be a citation? Percent of distance downstream is not as clear as just distance downstream but perhaps you are trying to scale it to any size of basin.

Several reviewers expressed strong reactions to specific statements within the manuscript - these points need to be addressed during revisions. Reviewers also suggested several ways to modify figure 1 - presently, it does not contribute to the readers understanding of variability. Which spatial or temporal scales of temperatures are being referred to? Some of the scenarios may not be possible at any scale. The dam emphasis in figure 2 should be broadened to include other temperature responses to landscape change.

Response from Technical Working Group Authors

October 16, 2000
Dr. Sherri Johnson
Oregon State University
Corvallis, OR 97331

Dear Dr. Johnson:

In my revisions on the spatio-temporal technical summary, I have addressed the following comments, which I believe represent the consensus conclusions of the Peer Review Group (PRG) regarding the paper:

PRG Comment: The paper relied too heavily on unpublished documents.
Revisions: More literature citations have been added and tables and figures from other sources have been integrated into the paper making the paper more of a "stand alone" document. Further, one of the most often cited references that was unpublished as of the last draft (Poole and Berman) is now "In press."

PRG Comment: The documents topic was relevant, but the relevancy of information contained in the document was not clearly articulated in the text. A contributing factor was that the document contained too much jargon for the intended audience.
Revisions: At the suggestion of the PRG, the document has been entirely restructured into a "questions and answer" format. The questions are designed to walk the reader through a line

of reasoning that shows how spatio-temporal temperature dynamics at multiple spatial scales are important for the management and regulation of stream temperature. The questions start out with extremely basic concepts (e.g., "What is temperature a measure of?" and "What is spatial and temporal 'scale?'") and attempt to provide the reader with the necessary background to understand the answers to more complicated questions later on in the text. Much jargon was eliminated. The relevancy of the topic to the management and regulation of stream temperature is highlighted in answers to several of the questions. Many supporting figures and tables have been incorporated to illustrate specific points.

PRG Comment: The technical summaries are redundant in some places and have gaps in others.

Revisions: This document now references each of the other technical summaries in a variety of appropriate places, pointing the reader to related discussions in other technical summaries. The biggest gap identified in the original paper was the lack of a discussion of "cumulative effects" which is now covered in detail in this paper. As discussion of the use of thermal refugia by salmonids was consolidated in the "Behavior" technical summary.

Other specific suggestions made by individual reviewers (usually in the margins of review copies) were incorporated as much as possible without over-expanding the intended scope or size of the paper. Most of these comments involved minor changes in wording or addition of a few sentences to clarify a point.

I hope the revisions are sufficient to address the comments of the PRG. If there are additional issues that need to be addressed, please feel free to contact me.

Sincerely,

Geoffrey Poole
US EPA Region 10 and 4

Summary of Peer Reviewer's discussion of draft of Issue Paper 4: Temperature Interactions

July 2000

Interaction is a difficult topic to summarize because there are so many interactions! It was good to see indirect factors being addressed.

Reviewers suggested that the physical section could include the effects of flow volume / discharge on temperature patterns, which can be a critical factor where water withdrawals are occurring. The sediment and photo biology topics were not clear. The section on chemical interactions should be condensed and all topics should have a clear tie to biologically important interactions for continuity within the text. A good limnology text could be referenced for those needing more details.

What about the effects and interactions between behavior, temperature and physiology? What about the interactions of predation and competition with temperature? Other overlapping topics include the interrelationships among temperature, disease and behavior. We expected to see the interaction summary addressing some of these interactions - but they could be addressed in the other issue summaries of behavior or physiology. Please clarify with the other authors which issue summary will tackle these subjects. The effects of temperature on food resources of salmonids (invertebrate growth, size as a function of temperature - Vannote and Sweeney 1980; decomposition rates of organic matter; algal growth) should be addressed in this summary.

A major question to discuss and clarify to the extent possible is whether temperature is an additive stressor or a multiplicative stressor. The answer depends upon the interactions being examined, but it could be a unifying perspective to address throughout the paper. In addition, a discussion of this sort would help policy and regulatory agencies better understand what the ecological tradeoffs might be with different temperature standards. This discussion could also address the issues raised during public comments and provide a framework for thinking about temperature interactions among genetically different stocks, with differing food rations, and with of duration of exposure. The fact that many stream ecosystems are already stressed in multiple ways (temperature, exotics, hatcheries, channel modifications, harvest...) means that our (somewhat limited) understanding of temperature responses are actually obtained by viewing responses to interactions of multiple stressors.

Reviewers felt that all recommendations should be deleted. Conclusion paragraphs 1, 2, and 3 provided overarching views. However, conclusions 4 and 5 did not make a strong case and need to be reworded or removed. Conclusion 6 was debated and there was not agreement as to its validity. We suggest that this conclusion be deleted.

Reviewers were concerned that citations within the manuscript did not reference the primary literature directly. It is important to read the original work, because each reader and author citing a study may have a slightly different interpretation than the original author.

Comments and suggested questions to address from reviewer # 5 were included for authors of physiology, behavior and interaction issue papers because the questions apply to all these papers and topics overlap. Reviewers urged that there be increased communication among the authors of these papers to clarify which paper is dealing with which topic. Cross referencing is essential among the issue papers to understand and hopefully explain why there may be conflicting temperature responses.

Reviewer #4 commented that in central California, they have found temperature responses to occur at different levels than those cited within some of the issue summaries. Although California salmonids may have different temperature dynamics (due to higher acclimation temperatures, different stocks, etc), similar comments may be submitted regarding streams in eastern Oregon and Washington. These types of comments need to be addressed and put into perspective within the text of all the issue statements.

Response from Technical Working Group Authors

October 17, 2000
Dr. Sherri Johnson
Oregon State University
Corvallis, OR 97331

Dear Dr. Johnson:

The Multiple Interaction Technical Summary has been substantially revised based upon the Peer Review Group's (PRG) comments. Responses to those issues summarized by PRG for this manuscript are provided below. In addition to addressing issues summarized from the PRG, a section on stress has been included within the introduction and supplemental sections have been added under the biological heading. An extensive table has also been incorporated into the disease section. Reviews conducted on this technical summary by PRG members are greatly appreciated.

PRG Comment: Reviewers suggested that the physical section could include the effects of flow volume/discharge on temperature.
Revisions: During the technical team's discussion of peer review comments, it was decided that this subject is best addressed under the spatio-temporal topic and should be included in that technical summary.

PRG Comment: The sediment and photobiology topics were unclear.
Revisions: Editing has been done to clarify. The physical section was expanded to include some addition headings and the photobiology was moved to the biology section as it fit much better following an expanded discussion on food web.

PRG Comment: The chemical section should be condensed and all topics should have a clear tie to biologically important interactions.
Revisions: Some editing has been done, however this section has not been condensed to much degree.

PRG Comment: Additional interactions to consider: behavior, temperature, physiology; predation and competition with temperature; and temperature, disease and behavior.
Revisions: The comment from reviewers was not very specific as to what aspects of these interactions they wanted discussed. Additional text has been added to the paper that hopefully clarifies these relationships. With regard to predation and competition with temperature, those topics were moved to the Behavioral Technical Summary.

PRG Comment: Overlapping topics exist within behavior, physiology, and multiple interaction technical summaries.
Revisions: Authors of technical summaries have coordinated and now overlapping topics are primarily embodied within one main technical issue paper with secondary, lesser mention in related papers. Dru Kennan has put together a table identifying topics which overlap and subject primary and secondary technical summaries.

PRG Comment: Effects of temperature on food resources of salmonids should be addressed.
Revisions: This interaction has been incorporated into the biology section of the paper.

PRG Comment: Clarify to the extent possible whether temperature is an additive or multiplicative stressor.
Revisions: Where possible, this has been clarified in the paper. The concept that temperature has a synergistic effect when combined with other stressors is now contained within the paper.

PRG Comment: Cite primary literature.
Revisions: Although I was able to get many of the primary literature references, there are others I'm still trying to obtain. If you decide its important enough, these references can still be incorporated into the paper.

If you have any questions or want to discuss these revisions, please contact me.

Elizabeth Materna
U.S. Fish and Wildlife Service.

Summary of Peer Reviewer's discussion of draft of Issue Paper 5: Physiological effects

July 2000
This paper had clear attention to detail, although for a summary paper, it is very long. Perhaps some sections could be shortened. Reviewers found the general format of asking questions and answering them to be valuable. In addition, reviewers commented that the numerical standards in tables were clear and helpful.

Several reviewers commented that a few topics were notably absent from the manuscript. To begin to address particular questions that will arise for setting standards and criteria, reviewers suggested topics to be included if possible:

- physiological stress, endocrine levels, heat shock proteins
- evolutionary differences
- individual variation in responses
- potential effects of the length of exposure to high or sub-lethal temperatures
- recovery versus relaxation responses after exposure to stress
- effects of full ration or satiation on responses
- potential differences in responses between tank and field studies
- potential differences in responses from using different stocks in studies

A discussion such as this would address the issues raised during public comments by OFCI and WFPA (attached) and provide a framework for thinking about genetic differences, effects of acclimation temperatures, effects of differing food rations, and effects of duration of exposure.

The type of temperature being discussed should also be noted (see measurement issue paper).

The tables could be improved upon by adding information to facilitate comparison among studies (also see summary comments of peer review panel). Several reviewers mentioned that there can be very different responses to physiological conditions depending upon stocks used, acclimation temperature, feeding ration (fullness), wild vs hatchery, tank vs stream study, and life stage. What about the effects of fluctuating temperatures vs stable temperatures often used in studies? Reviewers suggest that the state of knowledge on this should be clarified to the extent possible. All of these could be topics for expanded column headings for tables. The citation of each study listed in a table should also be included, possibly as a footnote. The type of temperature (max, mean, MWAT) being discussed should also be noted.

The figures used in ODEQ temperature summary might help clarify species-specific or life stage-specific requirements, and it was suggested that some version of these figures be included. If there is concern that these figures may be over-interpreted, perhaps the dividing lines between zones could be broader or fuzzier.

Reviewer #4 commented that in central California, they have found temperature responses to occur at different levels than those cited within the manuscript. Although California salmonids may have different temperature dynamics (due to higher acclimation temperatures, different stocks, etc), similar comments may be submitted regarding streams in eastern Oregon and Washington. These types of comments need to be addressed and put into perspective within the text of the manuscript, whether or not they might generally apply within the Pacific Northwest.

Comments from reviewer # 5 and lots of potential questions to address were included for authors of physiology, behavior and interaction issue papers because some of the topics overlap. Reviewers urged that there be increased communication among the authors of these papers to clarify which paper is dealing with which topic.

Summaries were used occasionally throughout the manuscript and several reviewers suggested that they consistently occur at the end of each section. The question format could be expanded throughout (parts of the manuscript don't have it) - depending in part if that type of format is to be the standard in all the issue papers. It does help to clarify topics.

"Physiological Ecology of Pacific Salmon" (1995) is not cited and reviewers commented that it would be a good reference to include.

Response from Technical Working Group Authors

October 16, 2000

Dr. Sherri Johnson
Oregon State University
Corvallis, OR 97331

Dear Dr. Johnson:

This letter describes the changes made by the authors of the physiological technical summary in response to comment from the Peer Review Group (PRG). I hope the revisions are sufficient to address the comments of the group. If there are additional comments, please contact me and we will try to address them.

PRG general comments on framework, Q&A format and conclusions.
Revisions: Due to the length of this paper, the format is not entirely consistent with the other summaries, but we made some revisions to bring it closer to the others and to make the paper more readable. The summary discussions from each section were brought to the front of the paper (the first 20 pages) with more detailed discussion and supporting information following. The supporting discussion was put into a question and answer format. The conclusions are at the end of the paper and we do not believe they contain recommendations.

PRG comment on overlap between papers.
Revisions: The technical committee discussed points of overlap in the papers and responded in two ways. In some cases the discussion was moved to one paper. The bulk of the disease discussion was moved to the multiple stressors paper. In other cases, we felt the topic needed to be addressed in more than one paper but in this case the papers should refer the reader to the others so they are aware that other aspects of the issue may be addressed elsewhere. Migration is a topic that remains in both the physiology and behavior papers. In the physiology paper we discuss temperature affects on migrating/holding fish and refer the reader to the behavior paper for discussion of the effect of temperature on migration behavior.

PRG comment to include more tables and figures.

Revisions: Several figures and tables were added to the physiology paper to better illustrate or summarize important information. We began to assemble a table on laboratory studies of lethality but decided for several reasons not to include it in the table. It quickly became overly cumbersome and complex and seemed to go beyond the objective and scope of this paper. Rather, we added discussion in the text on the variability of test methods, such as feeding rates, disease control, stock used for study, and others. We do have a table on test methods for bull trout studies, which will be added during technical editing.

PRG comment to add suggested topics.
Revisions: Under the heading "Other Related Topics," discussion was added on genetics and stock differences in response to temperature, particularly thermal tolerance. Discussion on the difference in responses between laboratory studies and field studies, as well as individual variation was added here as well. In the supporting information portion of the paper, discussion on physiological stress and heat shock proteins was added to the section on smolts, including reference to Castleberry et. al. Discussion on the length of exposure in tolerance testing and the potential cumulative effects of periodic short-term exposure to lethal temperature is included in the section on lethal effects.

PRG suggested references.
Revisions: Several citations suggested by individual reviewers were added to the paper, including papers on sockeye adult migration and swimming speed.

While the paper still needs technical editing, we believe the comments of the peer review group have helped us to improve it. Please let me if there are additional changes you or the reviewers believe are important to address in this paper. Thank you for your assistance.

Sincerely,
Debra Sturdevant
Oregon Dept of Environmental Quality

Summary of Peer Reviewer's discussion of draft of Technical Synthesis

February 2001

The Synthesis document was applauded for concisely presenting a complex topic. The Technical Summaries and the Synthesis document clearly reflect the large amount of work that has gone into them.

We discussed the audience for the Synthesis document and made our suggestions recognizing that it will be read by both non-scientific and scientific audiences. There was a bit of discussion about the Goals and this will be addressed more specifically in the review of the conceptual models. However, there is a slight mis-match between the goals on pg 1 of the Synthesis and those listed as "EPA Project Goals" (pg 1, Conceptual Models), because protection of high quality habitat and natural temperature potential of aquatic systems were not mentioned in the Synthesis goals. It was a bit confusing during our discussions, as we tried to refer back to the "goals" and they differed between documents. Several thought that including/referring to "Interpretation of Technical Goal" (page 1 of conceptual model paper) within this Synthesis document would be helpful: page 7 might be a place to pull this in.

Several members commented on the focus of the temperature criteria (ie salmonids) and suggested that a paragraph be added to explain why salmonids and to make clear that not just anadromous species or listed species were at issue. Introducing salmonids as indicators of beneficial uses - up front - might be good, even though it is in "project background".

Several members brought up that the tone in places came across as if it were an advocacy paper rather than a scientific synthesis for the public. We recognize that it's a fine line, but some statements came across too strongly and we discussed whether we really knew and could support what some individual statements were saying. Therefore, we made some suggestions for ways to tone down specific statements on the hard copy. Tying temperature recovery to salmon recovery is one of those fine lines. By keeping temperature in the context of its influence as one of multiple habitat factors, and that numerous factors will contribute to salmon recovery, there could be less backlash if stream temperatures are successfully returned to historic distributions and if salmon populations don't recover. We all know that more natural temperature regimes are important for many reasons in addition to salmon protection.

An example of a editorial suggestion, which hopefully does not change the message but neutralizes the tone, is on pg 14. In listing the 5 conclusions, we suggest that the message come first in the bullet, then give the supporting statement. And instead of "5 conclusions are apparent", "5 suggestions/actions related to thermal habitat issues are proposed by the technical work group" would clearly represent what these are.

Under "Human activities", tables 3 and 4 should be deleted. Table 3 is too much detail for this synthesis and a figure of the factors influencing temperature might be better. There are many of these figures already in the literature that could be pulled in showing the incoming solar, as well as advection, convection, conduction, evaporation - or not using those terms but still showing types of influences. Using that figure, you could briefly discuss what humans can manage/influence and what they can't (ie. discussing the content of Table 4 and not including it- since its not really a table but more of a list). This would then lead to presentation of Figure 4 and the results of human impacts on temperature (your list, #1-6, on pg 15 which are clearly presented also in Figure 4).

We had quite a bit of discussion on the tenets on pg 18. Statement #1 raised some concerns as stated and we discussed the need to make it clearer that human activities have lead to thermal degradation and that degradation is just one of the factors influencing salmon declines or limiting salmon recovery. A subtle point but we felt it important to spell out the steps. A suggestion for # 2 is on the attached sheet. # 3 appears to follow from the other two, but what about including protection when mentioning restoration to be sure to make the point (again) about protection of existing high quality thermal habitats. "Cold water habitat" came across as vague and disputable and simplistic - how about "seasonally appropriate temperature regimes" or high quality?
It appeared that the logic for the tenets was: 1) human actions ^{o} 2) physical impacts ^{o} 3) temperature regime modifications ^{o} 4) biological impacts and ^{o}) therefore all these need to be addressed/reversed (recognizing uncertainty) to ultimately meet Goals.

Specific comments are included on the manuscript. Most are fairly minor.

This synthesis is a nice summary of policy and technical issues regarding stream temperatures. Specifically, it provides a clear background on regulatory aspects of stream temperature, lays out the biological and landscape contexts, and outlines the need to proceed in the face of scientific uncertainties.

Comments on documents submitted to EPA Region 10 following request for information and studies relevant to temperature, salmonids and water quality

(organization or individuals submitting information are underlined below)

Oregon Forest Industries Council and Washington Forest Protection Association

- annotated bibliography of information and studies relevant to temperature, salmonids and water quality
- *key findings* and *relevancy* refer to those sections in the annotated bibliography submitted by OFIC and WFPA

report - **Evaluation of Oregon DEQ's temperature modeling and TMDL process**, prepared by CH2MHILL, Western Watershed Analysts, and Adams Consulting

This evaluation examined a reach based stream temperature model (Heat Source) - a network model is now being used and some of the concerns raised have been addressed. Because Version 5.5 is a reach scale model, a *key finding* that mainstem conditions are independent of conditions in upstream tributaries may not be within the realm of this model. Other broad statements (i.e. return to equilibrium temperatures) are missing important caveats. The *relevancy* points will not be true for many situations and should be considered in light of many other influencing factors.

report - **FEMAT riparian process effectiveness curves: what is science based and what is subjective judgement?** prepared by CH2MHILL and Western Watershed Analysts

This report examines FEMAT curves and suggests changes. Site specific and species specific factors do affect shade effectiveness. FEMAT curves were created to be conservative estimates which can be modified on a site by site basis on federal lands. The studies cited were all conducted in the western Cascades and coast ranges and likely reflect subregional responses.

report - **Evaluation of shade effects on water temperature of tributaries and mainstem of the Grande Ronde River**, prepared by Western Watershed Analysts and CH2MHILL

This report reevaluates ODEQ methodology of determining site-potential vegetation height and effective shade. The authors suggest that variability of conditions are ignored, which is a potential complaint for any model. *Relevancy* statements that recommend elimination of site potential vegetation classifications for shade are not supported and substitution of simpler models is a consideration but they would provide much less predictive power than Heat Source.

report - **Review of the scientific foundations of the *Forests and Fish Plan***, prepared by CH2MHILL

This review of the Plan notes a strong literature review and information on evaluating riparian management activities in terms of their influences on shade and stream temperature. The *key findings* of diminishing returns for shade are well supported generally, with absolute distances being site specific. That temperatures in non-fish stream may increase but be restored to

undisturbed conditions by strategically placed buffers is vague and dependant upon the site specific situations.

report - **Stream temperature considerations in the development of Plum Creek's Native Fish Habitat Conservation Plan**, Plum Creek Timber Company Technical Report #12

As correctly pointed out on page 8 of this document, regulatory agencies have to establish temperature criteria for sensitive species, such as bull trout, with limited knowledge or information on the influences of temperature on distributions. Plum Creek's report summarizes existing and new information on species distributions as a function of temperature. Several tables are very clear presentations of information and this style could be incorporated to the Technical Working groups issue statements (see tables 2.1, 2.5). Some information, however, is summarized as ranges, which does not increase our understanding of biological or physical factors influencing stream temperatures and fish distributions. In addition, presence of individual fish in reaches with high temperatures does not mean that there is a healthy, reproducing population there. Due to the high variability within some analyses, summaries such as figure 6.3 or 4.1 should be evaluated and not applied cautiously. Regressions do not imply causation, only correlation. The suggestion that shading of the lower 500 m of impacted streams will return stream temperatures to undisturbed levels is not well supported by this report or within the literature.

report - **Effectiveness of eastside target shade rule**, D. Glass, Boise Cascade Corp, 2/00

This report suggests that Washington's shade rule is effective for 95% of the streams studied. Because this study did not take into account other factors which can influence stream temperatures amd streams vary in their temperature regimes, it should not be extrapolated to infer that shade standards are overly conservative.

report - **Temperature and streamflow regulation by streamside cover**, prepared for Oregon Dept of Forestry by M. Newton and M. Zwieniecki, Oregon State University, 7/96

This report evaluates Oregon BMPs in terms of increases in temperature following forest harvest or conversion. *Relevancy* that transpiration might lead to loss of heat from streams should not be confused with changes in stream temperatures within the streams. If you pour out half of a pot of boiling water, you still have boiling water, although there is less total 'heat' because there is less volume. Trends of 'natural warming' with distance downstream are highly variable from stream to stream and should not be used as predictive measures (Caldwell et al. 1991, full citation below) Because flows were believed to be derived from local inputs, these may not be good streams in which to evaluate effects of upstream forest harvest practices and may be cumulative effects were not observed (*key finding*). The same sites are the subject of the report by Oregon Department of Forestry, "Effectiveness of Riparian Management Areas...", 1997 (for full citation see below)

report - **Salmonid populations in logged and unlogged stream sections of Western Washington**, prepared by P. Bisson and J. Sedell, Weyerhaeuser Company, 10/82

This report examined fish populations and habitat quality in streams through recently harvested and undisturbed forests. It documents greater total biomass in logged streams and notes shifts in species occurrences. Greater biomass of steelhead and juvenile cutthroat and lower biomass of

coho and adult cutthroat occurred in logged reaches. These differences were associated with habitat changes associated with logged reaches (loss of pool volume and large stable wood). Relevancy notes increased fish biomass after harvest, but this occurred due to increases in some species and decreased in other species.

report - **Evaluation of downstream temperature effects of type 4/5 waters**, prepared by J. Caldwell, K. Doughty, K Sullivan for TFW CMER Water Quality Steering Committe and Washington DNR, 9/91 TFW-WQ5-91-004

This report examined stream temperatures in small fishless streams in western Washington and noted similar temperature dynamics in small streams as in larger streams. Stream temperatures were shown to be influenced by their environment and small streams categorized by extent of shading and their elevation. The influence of increases in stream temperature on small tributaries to larger streams depends upon the volume of both streams. A mixing zone of increased temperatures for 150 m downstream of the junction of small streams with larger streams was suggested, but this would depend upon the specific site, stream volumes, differences in temperatures and amount of shade as well as many other factors.

reports - **The physics of forest stream heating: a simple model**, prepared by T. Adams and K. Sullivan, Weyerhaeuser Company, 5/89 & **The physics of stream heating: 2) an analysis of temperature patterns in stream environments basin on physical principles and field data**, K. Sullivan and T. Adams, Weyerhaeuser Company

These reports examine factors that influence stream temperature and finds large scale climatic as well as local conditions are of importance. Groundwater inputs are observed to be an important factor for small streams. A *key finding* that mean daily water temperature is always near mean air temperature when the stream is in equilibrium and that solar insolation has little influence after initial transient heating period is an oversimplification and subject to specific scales of observation. *Relevancy* that large streams fluctuate less than small streams is not supported by the literature. Even though strong correlations between water temperatures and air temperatures can be obtained with data at specific temporal scales, it does not imply that this relationship is mechanistically important in flowing water; both may be responding to other drivers, such as solar.

MANUSCRIPTS

Bebak et al. 2000 - This paper presents research on Arctic char hatching at temperatures between 6 and 12 ºC. Hatching success was a function of delay in increases of temperature until the eyed stage and a function of different genetic strains.

Beschta et al. 1987 - This paper reviews factors influencing stream temperatures, biotic responses to temperature and provides a literature review of pertinent papers published before 1987.

Bisson et al. 1988 - This paper examines coho habitat use and production in streams impacted by eruption of Mount St. Helens. The extent of diel temperature variation appeared to be strongly influenced by recovery of vegetative shading of the stream. Coho were observed to aggregate in

a cool water plume when main channel temperatures exceeded 22 ºC and mortality was not observed when temperatures were above 24.5 ºC. Availability of abundant food resources was cited as an important factor mediating the effects of summer extreme temperatures.

Bilby and Bisson 1987 - This paper notes movement of stocked coho in an old growth and clear cut basins as a function of changes in discharge. Emigration during changing flows and decreasing stream temperatures was greater than when temperature decreases occurred without a change in flow.

Bilby and Bisson 1992 - This paper examines production of coho, cutthroat and sculpin in forested and clearcut tributaries. Production of stocked coho and sculpin was greater in the clearcut streams, but cutthroat production did not differ between sites. Autochthonous food resources were greater in the clearcut and autochthonous resources were greater in the old growth forest. Temperature differences were not reported.

Brosodske et al. 1997 - This paper examined microclimatic factors in harvested riparian zones and found buffer widths of 45m each side were necessary to maintain the pre-harvest microclimate at streams. The *key finding* that numerous factors had no relationship with stream temperature should be restated clarified as having no correlation with stream temperature; this has been noted to occur at specific temporal scales of observation in other published manuscripts. In addition, the sites monitored in this paper were not selected to specifically examine effects on stream temperature and lengths of clearcut reaches upstream from the sensors were not noted. Sites may have occurred in the upstream portion of the harvested area.

Hokannson et al. 1972 - This paper examined growth and mortality of rainbow trout at fluctuating temperatures and constant temperatures. The authors provide a discussion of literature on the effects of fluctuating temperatures and note that instantaneous responses may lag exposure to high temperatures. As noted in *relevancy*, they suggest that temperature standards take into account magnitude of temperature variation.

Ugedal et al. 1994 - This paper examines growth of Arctic char after transfer to captivity and suggests that range of water temperatures and duration of exposure to high temperature affects survival, but that char seem well suited for rearing in aquaculture.

Zwieniecki and Newton 1999
see comments on report by Newton and Zwieniecki, 1996 (above)

executive summary of report - **Regional Assessment of stream temperatures across N. California and their relationship to various landscape level and site specific attributes**, T. Lewis et al. 2000
Full document which has just been published should be considered as input for types of conceptual models for regional stream temperature assessments

abstract of draft technical report - **An analysis of the effects of temperature on salmonids of the Pacific Northwest with implications for selecting temperature criteria**, K. Sullivan et al., Sustainable Ecosystems Institute 5/2000
Only a brief abstract was submitted.

method manual - **Stream temperature survey**, TFW Monitoring Program, D. Schuett-Hames et al. 6/99, TFW-AM9-99-005
This manual provides basic methods for data collection and recording of stream temperatures. It is meant to be accompanied by a QA discussion, where factors influencing placement of sensors and issues concerning frequency of measurement would hopefully be discussed.

MS Thesis - **Summer water temperature conditions in the Eel River system with reference to trout and salmon**, P.F. Kubicek, Humboldt State University, 1977
This thesis project examined water temperatures in the Eel River, using 30 thermograph recorders and hundreds of point observations over the course of the summer with hand held thermometers. Reaches are classified as lethal, marginal or satisfactory based upon observation and estimations of summer maximum temperatures. Observations of fish presence were not at the time of summer high temperatures. Although *relevancy* statements raise important considerations, this thesis research was not designed in a manner that supports these statements.

NCASI - National Council of the Paper Industry for Air and Stream Improvement
manuscript - **Temperature and dissolved oxygen in the Alsea Watershed study streams**, G. Ice
This manuscript revisits historic stream temperature and DO responses to forest clearcutting and partial harvest and includes updated information. Exposure of harvested site to increased solar radiation led to increased stream temperatures, while site with riparian buffers and patch cut showed little increase in stream temperatures. Increases of fine sediments within the stream occurred following clearcutting. Temperatures in clearcut returned to near pre-treatment levels with reforestation.

document - **Primer on the physics of forest stream temperature**, prepared by T.N. Adams
This draft document is a valuable overview and summary of factors influencing stream temperatures. It models stream temperature responses as a function of depth. It does not address cumulative effects or the scale of observation of factors within the environment influencing stream heat budgets.

reports - **Growth and survival temperature criteria for bull trout, 1998, and Growth and survival temperature criteria for bull trout, 1999**, prepared by McMahon et al., Montana State University
These reports provide results from experiments conducted to determine survival and growth of juvenile bull trout at constant temperature regimes. Initial results from constant temperature regimes suggest that 12 ^{o}C may be physiological optima for growth and survival if fed to satiation. Growth was maximized at lower temperatures if rations were limited. Interactions between brook and bull trout showed disadvantages to bull trout if temperatures were above 12 ^{o}C.

report - **Integrated headwater stream riparian management study progress report #4**, 2000, prepared by C. Rhett Jackson, University of Georgia.
This report examines stream temperatures in small streams before and after harvest with buffers and slash treatment. Differences in pre-treatment and post-treatment weather makes comparison difficult. Further analyses and more details on study plans could clarify evaluation of the effects of these treatments.

report- **Heat shock proteins as indicators of thermal injury and impaired physiological performance in bull trout**, prepared by Lee Weber and Gary Vinyard, University of Nevada, Reno
This report suggests that threshold levels for acute Heat shock protein induction could serve as surrogates for long term growth and survival experiments. Accumulation of specific heat shock proteins has been detected for fish gradually acclimated to 22 ºC and 25 ºC . Acute temperature elevation experiments will be conducted to examine thermal stability of proteins.

Forest Science Project, Humboldt, CA
report - **Stream temperature protocol**, Forest Science Project, Regional Stream Temperature Assessment
This report describes protocols for sampling stream temperatures. Discussion of sampling frequency and placement of sensors are included.

executive summary of report - **Regional Assessment of stream temperatures across N. California and their relationship to various landscape level and site specific attributes**, T. Lewis et al., 2000
This document should be examined by Technical Working Group for conceptual models for regional stream temperature plans. Also submitted by OFIC

newsletters - **FSP technical notes**
Newsletters discussing stream temperatures, sampling designs, and answering basic questions about monitoring. Also presented are graphs of weekly max, min and mean for several representative sites.

Oregon Department of Forestry
report - **Cooperative stream temperature monitoring, 1994-1995**, prepared by E.G. Robison, J. Runyon and C. Andrus for ODEQ
This report examines stream temperatures as a function of forest harvest in small, fishless coast range streams in Oregon. Small clearcuts resulted in increases in maximum stream temperatures. For several sites, maximum temperatures decreased after small, headwater streams (within 3 miles of divide) traveled through forested reaches.

report - **Evaluation of downstream temperature effects of type 4/5 waters**, prepared by J. Caldwell, K. Doughty, K Sullivan for TFW CMER Water Quality Steering Committe and Washington DNR, 9/91 TFW-WQ5-91-004
also submitted by OFIC

report - **Effectiveness of riparian management areas and hardwood conversions in maintaining stream temperature**, Oregon Department of Forestry, March 1997, Forest Practices Technical Report 3.

This report evaluates the effects of riparian buffers and hardwood conversion practices on stream temperatures in the coast range and western valleys of Oregon. Increased temperatures below forest harvest units were observed, and authors suggest that forest protection rules may not always provide adequate protection to meet water quality standards. Streams leaving managed areas tended to show a decrease in temperature after passing through an unmanaged forest, while those at lower elevations did not.

draft report - **Riparian function**; Issue - How well do current riparian protection practices on forestland provide for and maintain large wood inputs and stream temperatures necessary to maintain and recover salmonids, prepared by Forest Practices Advisory Committee on Salmon and Watersheds, November 1999

This report evaluates Oregon FPA for stream temperatures and wood. Many groups are working to ensure consensus on this document. Independent Science Management Team (IMST) in Oregon has made specific comments in its forestry report of September 1999. ODEQ is also working with ODF to evaluate whether these practices will protect stream temperatures. As a note - the results from Caldwell et al. (1991) regarding downstream recovery reach distances pertained specifically to downstream of the junction of small streams with larger streams.

Arrived independently

report - **A comparison of summer stream temperatures in unmanaged and managed sub-basins of Washington's Western Olympic Peninsula**, prepared by J. Hatten, Hoh Tribe and R. Conrad, NW Indian Fisheries Commission, 10/95 (Northwest Fishery Resource Bulletin)

This report evaluates the effect of timber harvest on summer stream temperatures in the Olympic Peninsula, Washington. Streams in managed sub-basins had significantly higher mean temperatures than the streams through unmanaged forested sub-basins. The proportion of sub-basin classified as late seral stage forest was a stronger variable for predicting maximum water temperatures than factors at the reach level alone.

Insight Consultants

These reports contain valuable data on stream temperatures in the Umpqua Basin and will be useful as documentation of local stream temperature patterns. Questions of attainability of specific temperatures are posed.

Oregon Cattlemen's Association

A response to the article by Larson and Larson by R. Beschta (published in Rangelands 1997 and included here) should be examined.